

VOICE TRAINING IN INDIAN MUSIC*

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The human voice apparatus is undoubtedly the most perfect musical instrument. It offers the greatest scope for voluntary manipulation and control of variations in pitch, quality and intensity. No musical instrument yet devised by the most brilliant human inventiveness could even approach it in any respect : its multipurpose uses, instantaneous adaptability, economy of construction and application, utterly individual quality etc.

The voice of each human being is different from all others; Voice-print has now come to be as widely employed as a technique in personal identification as thumbprint is.

The earliest attempts at systematisation of knowledge of phonation in speech and music are to be found in ancient India. Yet, contemporary musical practice in India reveals a serious defect in thought and attitude. There is little or no tendency to discriminate between technical excellence and artistic excellence in vocal music. The latter is often confounded, or equated, with the latter. We are too prone to accept or tolerate a harsh, hoarse, rough or strident voice if the artist has good poetic and imaginative gifts; and possesses good musicianship. We tend to forget that singing and musicianship are not synonymous and that the human voice is a musical instrument which must be studied, trained and cultivated. However excellent the musicianship, if he fails to sing dead in tune or sing the tones steadily or cannot consciously manipulate the vocal apparatus for optimum results, he cannot be — and should not be — called a singer. Such consistent tolerance on the part of the listener and ignorance on the part of the teacher and indifference or negligence on the part of the curriculum framers have combined to result in a systematic neglect of voice training in Indian music at both academic and professional levels and have reduced good performing voices in classical music to nothing more than mercies of nature and hardly to products of systematic and deliberate effort. This deplorable situation may be

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traced in part to the fact that Indian musical pedagogy, traditional or modern, accords no place to voice training.

The present paper aims at collimating both the ramifications of the problem in the special context of Indian (and particularly of Karnataka) music and data available on some technical aspects of voice training. The latter necessitates extrapolation from the area of body science discipline which I have freely drawn upon from current research work being carried out in Central and East Europe as well as in the U.S.A.

The object of voice training is to enable the singers to perform the musica-verbal tasks set for him by the particular system of music, composer, composition and theme, to the best of his capacity, through conscious and deliberate manipulation of his vocal apparatus for optimal results. Its aim is to develop the technical resources, explore and exploit the technical resources and develop skills inherent in and natural to, a given voice to the best advantage of the music and greatest pleasures of the listener.

Brief Discription of the Voice Apparatus

The human voice results from the interaction of two opposing forces; compressed air propelled from the lungs and muscular tension or resistance placed continuously in opposition to it. The mechanism of the voice may be therefore reduced in its simplest terms to : (i) the lungs and the respiratory muscular system which acts as bellows; (ii) the larynx which acts as a vibrator; (iii) the cavities in the chest, windpipe, pharynx and head which act as amplifier and (iv) the mouth organs such as lips, teeth, tongue and palate which act as articulator. The compressed air propelled by the chest, is set in vibration by the vocal cords in the larynx, which are amplified by the air in the above cavities. The articulator system imposes, through the numerous shapes it may assume, consonants and vowels on the phonated sound *i.e.*, add words to musical sound. Vibration with the wind pipe, is imparted to the air by two lip-like muscle tissues called vocal cords. These are two adjacent membranous tissues situated in the larynx just above its junction and lie in the same horizontal plane and run from the front to the back. They are about 0.75" in men and about 0.5" in women; they probably touch each other when closed, but open widely during breathing; their length, thickness and tension may be changed within limits, thus giving rise to different pitches, more or less conforming to Mersenne's laws. Besides thus behaving in stringed instrument, the vocal apparatus also behaves like a double reed wind instrument — the vocal cords providing the double reed. When a note is sung the vocal cords probably touch each other at the inner edges at each vibration, thus closing and opening the glottis alternately. This gives the fundamental of the note being sung.

The air from the vocal cords next passes up through the pharynx, across

the upper surface of the tongue and out through the lips, or behind the soft palate into the nasal cavity, and out through the nostrils. The tongue and the lips may be manipulated in a large number of ways, resulting in different shapes and sizes of the cavities of the throat, mouth and nose etc. The air in these cavities and in the sinuses, resonates with the fundamental; the shape and size of each such cavity vary from individual to individual. And for a given individual the conscious manipulation with lips, mouth and throat multiplies the component contributory factors by a large number. Add to these the structural individual variations in the vocal chords as well as the voluntary changes wrought in their length, thickness and tension. The final result is a quality in the voice which is utterly different from others. Thus the unique feature of the human voice apparatus is that the size and shape of the resonant chamber is under conscious control of the performer.

Thus of the three aspects of musical sound, pitch, quality and intensity, the fundamental in the pitch is accounted for by the length thickness and tension of the vocal chords; quality derives from the unique pattern of upper partials produced by the resonating cavities of the larynx, palate, nose, sinuses etc. The loudness of the voice, *i.e.*, the intensity of the sound, depends on the pressure with which air is forced from the chest cavity through the vocal cords. This varies with pitch for both men and women. The intensity is longest at the top of the vocal range of a given person, raising to a maximum of about 1 watt in power. This is about 1/70 of the energy of an orchestra of 75 performers at its maximum loudness, about ten times as large as for the same orchestra at its average loudness, about 33 times the average loudness of a bass voice and about 4,000 times the power of average speech.

Technical Requirements of Good Singing Voice

It is appropriate to enunciate the requirements of a good singing voice before discussing voice training procedures. Such requirements may be studied from at least five view points.

The following elementary technical demands are made on a singing voice :

- (i) The Phonation must be sonorous, *i.e.*, ringing, clear, bright and lustrous. It should not be dull, hollow, rough, strident, shouting or braying.
- (ii) Ability to produce at will the finest quality of a given tone in the contest of the natural resources and limitations of the given voice apparatus.
- (iii) Perfect intonation and perfectly steady tone.
- (iv) Ability to maintain a continuous and steady flow of sound over the full vocal range and at the speed demanded by musical necessity.

(v) Voluntary and instantaneous control in increasing or decreasing the loudness of a tone.

(vi) Ability to colour the voice with affective expression or expressiveness.

(vii) Ability to flex the voice to perform various curvatures in musical notes.

(viii) Agility.

(ix) Stamina to sustain performance over a reasonably long period of time.

(x) Clear enunciation and articulation of the literal content of music without sacrificing musicality.

Acoustical Requirements

From the acoustical standpoint, the following demands are made on a good singing voice :

(i) A voice quality which is referred to as "*Gaula Sarira*" in musical parlance. This roughly corresponds to the concept of vibrato in Western Music. Vibrato is defined as a pulsation of pitch, usually accompanied by synchronous pulsations of loudness and timbre of such extent and rate as to give a pleasing flexibility, tenderness and richness to the tone. It is an acoustical truth that no voice is really steady at any given tone for any ordinary duration but that it varies fairly evenly at about 6-7 cycles per second, the variation embracing pitch, intensity and quality. This is responsible for the so-called life, warmth or richness of the tone. Every good singing voice, even when heard by the naked ear as steady, is bound, on acoustical analysis against a time-scale, to possess the vibrato. Too little vibrato makes the voice rigid or brittle, too much makes it unpleasant and unstable. Some voices naturally possess it while others do not. But it may be induced in the latter and improved in the former within limits by manipulation of the laryngeal muscles and cavities, and training in the appropriate breathing technique.

(ii) Stress without strain; that is ability to produce satisfactory loudness with effortless ease. This requires a relatively enlarged throat, allowing free passage to the sound and free action to the vocal cords; *i.e.*, the avoidance of partially closed epiglottis and constricted pharynx.

(iii) Support to the natural frequency of the pharynx, which seems to be about 500 cps. for Western hemisphere. This formant needs to be determined for the Indian Voice. Good singing voice employs pitches which

naturally resonate with this, thus acquiring a roundness, resonance or richness. This is done by emphasising the lower of the two formants for the given vowel. Again, this law characteristic frequency varies from 296 to 955 in male voices, and from 332 to 1036 for female voices, for various vowels in the Western hemisphere. These values have to be determined for the Indian singing voice taking into account the extreme variations in geography and climate in India, and of course, for individual voices. This may be done by appropriately modifying the resonant cavities of the mouth and pharynx through voluntary control of the respective muscles and position of the tongue.

(iv) While the low formant of the vowel confers roundness and resonance on the voice, the upper formant, *i.e.*, the high characteristic frequency and the related components offer intelligibility on the sound. They contribute to "shimmer" or "ring" in the voice. Its occurrence is more or less universal and is probably due to a rigid part of the voice apparatus such as the hard palate. Its value varies from 1800 to 3000 c.p.s. in male voices and from 2000 to 3266 c.p.s. in female voices, in speaking voices in the West. Corresponding data for Indian speaking and singing voices in the context mentioned above, are not available. This contribution to the voice quality may be brought under voluntary control by manipulation of the resonant cavities of the mouth, pharynx and the sinuses.

These requirements suggest the urgent need for quantitative studies in musical vocalisation.

In this connection, the role played by different upper partials in determining the tone quality of the voice may be briefly mentioned. Amazingly, as many as 35 upper partials are active in the human voice; for example, the 25th partial, which is the upper formant for the fundamental pitch of 110 c.p.s. in male voice is clearly operative and contributory. However, the fundamental frequency of the human voice is largely accompanied by lower partials with relatively high energy distribution. Richness in tone quality also stems from a predominating fundamental frequency. High energy distribution among the even numbered partials contributes to roundness, resonance and brightness. Softness arises due to low energy in, or absence of, higher partials. Predominance of odd numbered partials produces hollow and nasal quality in the voice. It is observed that the second partial contributes brightness and bell-like clarity to the tone quality; the third adds brightness and also a hollow, nasal quality; the fourth contributes further brilliance, and some shrillness. The fifth partial adds a rich aerophonal quality while the sixth introduces a delicate shrillness. The odd numbered partials commencing from the seventh one deleterious to a good singing voice and tend to make it rough and harsh.

Acoustical research has shown that at least five air cavities in the vocal

apparatus are important for voice production. The vocal cords determine the pitch of the note; cavities of mouth and pharynx may be modified by tongue and lip positions and determine vowel enunciation; therefore they partly determine the quality through defining the formant region. The remaining air cavities such as the sinuses are responsible for musical quality of the sound.

An important and urgent line of work of immediate, practical relevance to any programme of voice training is to determine what components of the voice apparatus give rise to which partial and how the former may be modified to augment or inhibit a given partial. The voice spectrum of each serious student of vocal music obtained periodically and collated with the results of physiological examination should be necessarily integrated into voice training and voice therapy in any academic body of music education.

Enunciation in Singing

The demands of enunciation on a singing voice may now be briefly mentioned. Vowels are the vehicles of musical sound and consonants are the vehicles for meaning of the word content. Consonants are voiced if the vocal cords participate in phonation and are unvoiced if they do not. Consonantal sounds are impulsive and proceed in terms of spurts. They contain transients, that is short duration in which the sound is built up and decays. A consonant is produced when an obstruction, is offered completely or partially to phonation; the point at which the obstruction is offered is the point of articulation. If the obstruction is complete, the sound is referred to as a stop, if partial, producing friction, the sound is called fricative or spirant. The major points of articulation recognised in the human vocal system are the lips, the teeth, alveolae (teeth ridge), the hard and soft palates, Uvula, pharynx and the glottis. The analysis and classification of consonantal and vowel sounds by ancient Indian phonetists evokes admiration and respect even today. The apex, blade, middle and dorsum of the tongue interact separately with other articulators, producing various consonants.

Needless to say, the consonantal content and its articulatory organisation are peculiar to each language and these are products of long and continuous habituation. This results in uniform, general structure of the articulatory system of the voice apparatus of a given linguistic community; this in turn influences on the components bearing on the tone quality of the voice. In other words, the language structure and general voice quality are closely related. Yet, unfortunately, no study appears to have been devoted to this subject. At the level of the individual enunciation of the consonants has a direct bearing on voice production and voice quality. The techniques of consonant production for speech and singing are different, in spacing, shapes and energy. Systematic training in enunciation of vowels and consonants is of some significance to the tone quality of a good singing voice.

The intelligibility of the intoned sounds largely depends on the care with which the consonants are vocalised. The acoustical structure of vowels, which are the vehicles of tones, are of primary relevance to the improvement of voice quality. The following acoustical phenomena govern vowel production :

(i) Every vowel sound is characterised by the presence of one or more well defined groups of partials.

(ii) Such partials constituting a characteristic group are more or less symmetrically distributed around a central partial.

(iii) The frequencies occurring in each characteristic remain much the same, whatever the fundamental frequency.

(iv) The proper order and intensity of the partials giving rise to a given vowel are generated by modulations i.e., shaping the cavities of the mouth and pharynx in an appropriate manner.

I trust that the significance of the last statement will be appreciated in the context of voice training.

Instrumental Technique

A few remarks on the importance of breathing and *gamaka* may now be offered. How we breathe determines how we sing. This is true not only in relation to an individual, but equally so to ethnic groups. The phonemes or phonetic units of any language are the products of breathing through the mouth or nose and its complete or partial stopping at various articulatory points. While the Indo-semitic languages stress the role of explosion in breath or expiration, several African native languages illustrate the role of imploded breath or inspiration. Such habituation of the voice apparatus to a given system of breathing variants in a given ethnic group clearly results in a distinct collective evolution of the voice apparatus; this confers a collective distinction on the voice quality and vocal technique in music. This line of reasoning opens up a new field of investigation in ethno-musicology, viz. voice-typing based on method of breathing. My esteemed friend Prof. Rouget, Director of Musicology, Musée de l'homme in Paris, is doing admirable pioneering work in this direction.

At the individual level, some general suggestions may be made, calculated to aid the teacher and pupil in vocal music. The famous bel canto school in Italy laid the foundations of a foundational technique, viz., voice upon the breath. The singer must feel his voice as floating upon a moving stream of breath. This was tested by bel cantist by holding a candle flame or a mirror to the tone; breathing was adjudged correct if the flame did not flicker

or the mirror did not cloud. The sonority of the voice is increased when the sharp edges of the glottal lip's brought us close as possible, when the singer does not at all feel the outflow of breath from the mouth. Singing maestros of the West advise the pupil to lean the breath — near the top of the larynx — on the mask of the face. That is the tone should be formed in the laryngeal cavity and not at the mouth; the breath should be stopped by the false vocal cords as a preliminary to phonation. This technique is called 'coup de glotte'. In my opinion this is superior to the modern method of mingling the breath with the voice.

It must be remembered that the vocal apparatus was originally designed for speech in human beings and not for music. Therefore effort should be bestowed on adapting it to a musical purpose. The first step in such direction is to develop voluntary control of rapid contraction and relaxation of the muscles of the larynx, if the demands of tone quality and compass are to be met. The most important aspect of such preparation is to maintain an optimal relational position among the components of the vocal mechanism. Thus the body should be erect, chest well raised and the stomach slightly drawn in. The shoulders should be slightly thrown back. The singer should be firmly seated. Excessive movement of the body, postural or Kinetic, should be scrupulously discouraged. The singer should never lean on the stomach, hunch the shoulders, or depress the neck or the head. In other words, a free and maximum air supply should be ensured. The larynx should then be positioned in a slightly lower position than normal, by raising the soft palate. Next, the mouth should not be opened too widely because this automatically closes the throat; in other words, the lower jaw should not drop too much, but should be slightly drawn in. This enlarges the laryngeal cavity. The tongue root should never be stiffened. The soft palate should be raised and firm. The tongue must be placed firmly in the given vowel position. The importance of the tongue position can never be emphasized enough in the production of a singing voice. It should not be limp, should not be drawn back or stretched or flattened. Many singing voices which are potentially good sound thready, guttural, strained and rough because this important tenet is not realised. The vowel moulding and therefore partly quality determining mechanism consists, principally of the soft palate and the centre of the tongue, though other components do play an auxiliary role. The upper abdominal muscles under the breastbone, should be contracted, while breathing, to push the diaphragm upwards gradually without jerking; the larynx should be allowed to move the breath out of the lungs and not *vice-versa*, that is breath should not be allowed to jerk out in rapid spurts during phonation, but the upper chest muscles must gradually and slowly recoil, so that this weight pushes the air out, through the glottal lips; thus the voice should "suck" the breath out, as it were. This is known as 'respiratory squeeze' technique in voice training. This is the only logical mode of control available for the voice mechanism, because while the inward contraction of the upper abdominal muscles are susceptible to voluntary and exact control, the recoil

of the lung muscles is not. It is very important to learn to draw together the false vocal cords by manipulation of the appropriate muscles and to dilate the ventricles of Morgagni. This will be found to produce a sudden improvement in tonal quality. This technique corresponds to the expression 'to sing from the navel' for the singer feels that the tone proceeds not from the larynx or the mouth, but straight from the bottom of the lungs. This is an unambiguous indication that breath is being managed correctly. Abdominal breathing is most injurious to singing and should be avoided at all costs.

During inhalation, the abdominal muscles should first be slightly pushed out and slightly drawn in, pulling in the lower abdomen from the very beginning of inspiration. The advantages of *Prāṇāyāma* for breath management in singing are galore and must be carefully integrated into any scheme of voice training.

To sum up, the lungs should be used for emitting the tone, the glottis for pitch, the oral cavity should be used for vowel and quality, while the front of the mouth should be employed for producing consonants.

The style of singing is especially relevant to voice training. The bel canto school formulated various vocal styles such as the canto spianato, canto fiorito di agilita, canto fiorito di brvura, canto fiorito di maniera, canto declamato serioso, canto declamato buffo and corresponding training methods, in consonance with the requirements of opera, oratorio, etc. The most important single factor in the melodic content of Indian music, is the technique of embellishment of musical notes, called '*gamaka*'. In Karnataka music especially, there is not a single note of the scale except *shadja* which is sung or played in its exact theoretical position. This is in fact the strength and essence of the music. *Gamaka* is the displacement of a note from its theoretical position to confer a specific denomination, a specific shade of musical meaning. Almost infinite variation is possible in such displacement, but they are broadly classified under fifteen, ten, or even seven types. Some of these are specific to instrumental technique. *Gamakas* for the voice may be divided into slow and fast. In practice, agile voices are often found to be poor in slow *gamakas* while slow voices are often poor in fast *gamakas*. This is related partly to the natural quality of the voice and partly to lack of adequate training. While it is desirable to develop the natural propensities in *gamaka* of a given voice to optimal efficiency, it may not be feasible to completely adapt the slow voice to fast *gamaka* and vice versa. But it is certainly desirable that each voice should be trained for the other *gamaka* type systematically in regular propadentic exercises. This should be introduced early in any voice training programme in Indian music. The major types of *gamakas* in frequent passage should be broken down into isolated elements and mounted on appropriate melodic phrases for the pupil's practice. I stress its need in a programme of voice training in Karnataka Music.

Textual Prescription

Before proceeding to the final section of this paper on the physiology, pathology and therapy of the singing voice, it may not be inappropriate to ask : what does tradition — oral or textual — say on voice training? The answer, so far as I know is, Nothing ! what methods were used in training the voice for enunciation and singing in ancient and medieval India are now shrouded in the mists of time. It is both unfortunate and strange that the biographies of even such relatively recent figures as Thyagaraja or Maha Vaidyanatha Iyer who are reputed with excellent singing voices, should be silent on this point. The only residue of voice training now remaining — and now fast disappearing — is the '*Akārasādhana*'. While this method merits a close examination; the need for brevity compels me to be content with the observation that this does not appear to have provided for individual needs and individual variation.

What is more strange, perhaps, is the uniform, stubborn silence in our musical treatises on so vital a subject as voice training. Even works which run to several thousand verses and devote themselves with gay abandon to the description of the archaic, obsolete or technical trivialities, say nothing. What is the concern of the historian? The best that the best of them can offer are descriptions of good and poor voices and of a poor singer. I shall paraphrase these from the *Prakirṇaka Adhyaya* of the *Sangitarathnakara* of Sharṅgadeva.

Thus the singing voice is defined as coeval with the human body, capable of musical expression — *raagaabhivyaktishaktatvam* — with effortless ease. *Raga* here is extended by the commentator Kallinatha to mean *ragas* of Indian music. The above general interpretation of the term would seem more appropriate. Its qualities are described as wide scope (in the registers), resonance, appeal, tenderness, sweetness, depth denseness, smoothness, lustre and expansiveness (spreading in all directions). Its defects are enumerated as dryness, absence of appeal and of upper partials, saplessness, thinness, harshness, crowing, inaccuracy in pitch and register. No less than twentyfive varieties of bad singing are enumerated. A vocalist who sings with clenched teeth is named as *Sandashta*. If he sings with a divergent shouting voice he is called *Udghushta*. If he has a whistling or snorting breath, he is *sutkari*. A vocalist afflicted with stagefright is *bheeta*. *Sharkita* is dubious and (therefore) sings fast. *Kampita* naturally trembles in body and voice. *Karali* makes awful faces and opens wide his mouth while singing. *Vikala* sings the notes out of pitch. *Kaki* crows harshly like a crow; *Vitala* fails in *talā*. *Karabha* raises his neck like a camel. *Udbhata* is indeed the worst of the lot; he has a voice like a goat. *Thambaka* has such a strain while singing that veins stand out on his forehead, face and neck. *Tumbaki* puffs up his cheeks like a bitter gourd. *Vakri* twists his neck while singing. *Pravari* moves not only in song but also in body on the stage. *Nimeelaka* sings with shut eyes.

Virasa is a bore. The *apasvara* sings the proscribed *not*. *Avyakta* sings with convulsive inarticulation. The *sthanabhrashta* fails in reaching the desired register. *Avyavasthita* is disorganised in pitch and register. *Mishraka* is mixed up in the various kinds of *ragas* and mixes up the shades, of different *ragas* in the *raga* he is singing. *Anavadhanaka* is careless in executing characteristic phrases and *gamakas*. *Anunasika* sings through his nose.

Physiology of the Singing Voice

Among physiological requirements for a good singing voice, the following are the more important : flat and easily movable tongue, broad, flat and hard palate, flexible palatal velum, small and healthy tonsils, normal dental occlusion, wide supraglottic resonator, nose free from disease, undeflected septum, wide laryngeal vestibule, erect epiglottis, slender ventricular folds and symmetrical vocal cords perfect in movement. These are, of course, natural endowments, but should be taken into serious consideration when admitting students to serious and advanced vocal music courses. Such a physiological screening should help in encouraging the properly equipped pupils to take up singing as a professional career, in unexpected discovery of latent potentiality and of course, in shunting off poorly equipped aspirants to more suited courses of musical instruction. Periodical physiological examination of serious students of vocal music should be of much value in setting up corrective habits and augmenting techniques. A free, unhurried and sympathetic discussion of the malformations or defects of the vocal apparatus between student and the laryngologist will help reduce frustration and tension among the ill equipped aspirants and will help to infuse confidence, enthusiasm and intelligent application among those who practise corrective habits.

Voice Abuse

Related to the foregoing are questions of voice abuse and optimum pitch. Singers are often found to employ a pitch range which is not optimum to their physiological endowments. This is due to a variety of reasons; first, the average vocalist is also a teacher and his livelihood is derived largely from teaching music rather than performing music. A teacher has little option in the selection of his pupils, if he gives private tuition. In fact, he very often has to solicit work. As such he has to teach pupils of both sexes, different ages, voice types, I.Q. and varying degrees of musicality. His voice therefore loses its own individual and native quality soon and is continually exercised under nonoptimal conditions. Second, in cases of such disparity in natural pitch range, both teacher and pupil have to compromise on a common pitch standard which is more often than not well removed from the pitch optimum to either. This places the voices of both under constant abuse. Third, the pupil, who normally learns from the teacher by copying, unconsciously develops physical and vocal mannerisms of the teacher even though these are unnatural and undesirable in himself or herself. Fourth, the average Indian singer

tends to use a progressively lower pitch standard and limits his repertoire accordingly. He seldom tries to discover the lower and upper limits of the pitch range of which his voice is really capable. The employment of a pitch standard lower than the optimum arises out of his fear of failure in the higher notes during performance. Fifth, the abuse of his voice arises out of his ignorance of the nature of formation and manipulation of the vocal apparatus and consequent incorrect habits. Sixth, an "emotional" singer is habitually under mental stress which is extramusical and extraaesthetic during performance and this seriously affects the voice.

These and other causes result in the abuse of voice habitually below or above the pitch level optimum to the particular voice. It is therefore necessary to determine by systematic experiment the optimum pitch of the aspirant's voice and then maintain his learning and performance constantly at or near this pitch. Four different methods are described in the relevant literature to determine the optimum pitch. The first defines optimum pitch in relation to lower limit of the vocal tract. First the total pitch range of the person is determined from the lowest note to the highest, including flasetto. Then optimum pitch is expressed as a fraction of this range above the lower limit. Unfortunately, the findings of different workers are not uniform. For example, Pronovost, Fischer, Fairbanks, Berry and Eisensen give the optimum pitch as $\frac{1}{4}$ above the lower limit, while Berry and Eisensen give it as $\frac{1}{3}$, and Brownstein and Jacoby give it as one-fifth above the lower limit. The second method defines optimum pitch as the pitch at which swelling resonance occurs. The third method defines optimum pitch as the pitch of least mental or physiological stress, or greatest relaxation and identifies it as the pitch of coughing or laughing. The fourth relates the optimum pitch to the upper limit in the context of total pitch range. Nataraja, working at the All India Institute of Speech and Hearing at Mysore, with a group of men between 20-25 years of age, has shown that the optimum pitch is one-eighth of the highest pitch of the vocal tract.

Vocal abuse is closely connected with vocal irregularities occurring due to physiological causes also. Four such phenomena may be noticed : As a result of pressing on the elevated velum, the nasal resonator is opened and the pitch is lowered by about a semitone. If the resonating tube is improperly positioned, the pharyngeal and oral resonating spaces are constricted. This is caused by over contraction of the pharyngeal musculature, such as excessive elevation of the velum, contraction of palatal pillars towards the midline etc. This is known as parakinetic hyperfunction and results in throaty, constricted, strident, piercing etc., voice. This may be due to malformation or wrong habituation in manipulation of the vocal apparatus. Suggestions offered in respect of vocal abuse and optimum pitch are equally relevant here.

A mysterious phenomenon, the cause of which is not yet clearly understood, is that continuity of tones is lost in transiting from one register to its

adjacent one. I repeat; setting up corrective habits to produce optimum voice quality and optimum pitch by modifying the relative dimensions of the laryngeal vocal generator, is as yet unknown in Indian musical practice. Its importance can hardly be exaggerated.

Voice Pathology

This leads us naturally to the pathology of voice. Besides vocal disorders or diseases due to psychogenic factors, I shall include here dysphonias arising out of physiological and neurovegetative conditions also, for completeness. The following nine major dysphonia types may be distinguished.

(i) *Primary dysphonia and secondary laryngitis* results from the formation of polyps and nodules. These are known to be formed due to organic malfunctioning or due to psychoasomatic conditions, such as stresses in personality structure. Ageing female voice, especially in the climacteric condition suffers, for example, from such organic malfunctioning as edema, hyperemia or thickening of vocal cords. Psychological factors causing polyp- or nodule formation include emotional instability, domineering attitude, frustration and increased aggressiveness at this transitional stage in women. Again, contributory factors for emotional imbalance include mental (cortico-thalamic), neurohormonal (thalamopituitary), voice expressive (extrapyramidal or neuro-vegetative) conditions. Endocrinal automacities are very sensitive and susceptible to such emotional factors and thus a vicious circle is set up.

As a consequence, the voice becomes lowered, hoarse, harsh and aggressively masculine in range and quality. Alcohol and tobacco habits in men tend to make the voice lower, hoarse, hollow and rough. Nodulation, granuloma and polyp formation are found to occur in about 46 per cent of total laryngeal lesion cases and about 75 per cent in men. These are caused by vocal abuse discussed above and almost always result in psychopathic condition. These are treated in the chronic stage by surgical excision or vocal-cord stripping, followed by total voice rest and rehabilitation of voice. Psychiatric treatment is an integral and desirable part of the treatment. Acute intubation granuloma, nodulation and polyp formation may be cured in initial stages by corrective therapy.

(ii) *Endocrinal dysphonia* is prolonged, delayed, arrested, precocious or perverse vocal mutation and may be treated by hormonal adjustment. Vocal mutation is discussed below at some length.

(iii) *Paralytic dysphonia* is caused by laryngeal or neural paralysis and may be treated by medicine or surgery, physiotherapy, voice therapy, latero-fixation and phonosurgical narrowing of the glottis, etc.

(iv) *Dysarthric dysphonias* are disorders of the voice due to malfunction of the central nervous system and may be treated by neurosurgery and drug therapy.

(v) *Myopathic dysphonia* sometimes follows surgical section such as removal of tonsils or paralysis of sternothyroid muscle. It is diagnosed through loss of high tones, reduction of vocal range, confusion in registers and their transitions and reduction in phonation time etc. This may be treated by surgical section of strap muscles of the cervix so as to reposition the exerted muscles.

(vi) *Neurovegetative dysphonia* : In *Horner's syndrome*, high tones are lost owing to interruption or malfunction of the sympathetic nervous system. *Vasomotor Monochorditis* consists of the reddening, swelling and infiltration of a single vocal cord. This may result from one or more of the following conditions :

- (a) incipient laryngeal tuberculosis with infiltration of one vocal cord
- (b) gummatous infiltration of one cord from syphilis
- (c) early vocal cord cancer
- (d) laryngeal contact ulcer largely originates from intense emotional stresses

Therefore this type of dysphonia often necessitates psychotherapy also.

(vii) *Traumatic dysphonia* consists of laryngeal injury. Lesions of vocal cord may cause phonic disorders due to irregular free vocal cord (marginal) excavation, deficient adduction, granulation etc.

(viii) *Habitual dysphonia* : Two subvarieties of this dysphonia may be distinguished.

(a) *Habitual hyperkinetic dysphonia* results from faulty habits, such as excessive contraction of all the muscles participating in phonation. This is a severe form of vocal abuse and may be initiated by psychogenic stress, practising with unsuited reference pitch, unhealthy and massive compromise with one's own optimum pitch while teaching or learning singing etc.

(b) *Hypokinetic dysphonia* is a psychosomatic condition in which the voice becomes veiled, weak, breathy and fatigued. This condition is brought on by self-punitive, regressive, withdrawing or masochistic breakdown of passive submission. This is caused by emotional insecurity.

(ix) *Psychogenic dysphonia*, also called *aphonia* is body reaction to overwhelming mental stimulations with emotional fixation. It therefore

represents a general state of emotional maladjustment. *Phonophobia* is the fearful anticipation of failure during a performance or the fearful anticipation of being inhibited during a performance. This is invariably accompanied by worry, tension and anxiety, such anticipation may be conscious or sub-conscious. This condition sometimes manifests in physiological disorders, such as temperature rise, stomatitis, laryngeal inflammation etc., the etiology of which remains hidden. These conditions cannot be diagnosed or treated, except through psychological and psychiatric techniques.

Voice Therapy

The subject of voice therapy may be now discussed. Voice therapy may be attempted at three levels :

(i) *Compensation procedures* include the following :

(a) physical methods such as heat, infra-red light, diathermy, electrical stimulation with currents, vibratory massage etc., is used in myopathic or paralytic lesions.

(b) In laryngeal therapy compression neckbands are devised to combine pressure therapy with electrical stimulation.

(c) In electrical therapy isochronous, electromechanical tone massage is employed, i.e., mechanical vibration of the same frequency as the vocalised tone is applied to the larynx. This is an augmentary procedure.

(d) In psychotherapy, sympathetic interest in the problems of the patient who has lost or damaged his voice, unhurried discussion of a potential solution to fortify the patient's psychosomatic defences, should be attempted at a superficial level.

Thus formal or professional psychotherapy must become an indispensable part of *phoniatrics* in India, if we are to look after the welfare of the voices of our singers.

(ii) Disorders of phonic respiration may be set right by corrective habits such as optimal breathing therapy, diaphragmatic breathing, active relaxation therapy, correction of neuro-vegetative imbalance, systematic yawning to achieve maximal widening of the supraglottal resonators, hypnosis to increase self concentration on internal sensations etc. The role of yoga and especially of the different methods of *pranayama* as corrective and curative techniques is invaluable in Indian musical practice. These techniques should become an indispensable part of the curriculum in every institution where singing is taught.

(iii) Medicinal therapy, is of course, extensive and of varied application. Formal drug therapy employs antibiotics to eradicate vocal infections, antihistaminics to reduce allergic laryngeal edema, corticosteroids to reduce inflammation, hemopoietic minerals and vitamin supplements for recovery from stress syndromes of infection and surgery, vitamin B-group to aid recovery in paralytic lesion cases, psychoenergisers to decrease depressive reaction to emotional trauma, tranquillisers to reduce emotional disturbance caused by nervous hyperirritability and vegetotropic drugs to depress the overstimulated parts of the autonomous nervous system or to stimulate its depressed or exhausted parts etc., etc. This of course is only general therapy but is of inestimable and essential value, when applied *mutatis mutandis*, in treatments of voice disorders.

Attention may be drawn in this connection to two things of interest and importance : psychiatric method or other psychological techniques are of fundamental value in the treatment of dysodias i.e., functional disorders of the voice. Deep psychological understanding and sympathy with the personality and needs of the artists is often a major part of the treatment. Secondly, treatment of various vocal and other disorders is carried out currently in Europe by administering various warm, cold, radio-active or mineralised waters for drinking and bathing. This is found to possess undoubted psychological curative value. It is necessary to emphasize here that these are not placebos. It is simply that the *modus operandi* of these waters in effecting a cure is not clearly understood. This is known as balneotherapy. I submit that balneotherapy has almost unlimited scope and usefulness in India not only in terms of the availability of numerous such waters, but also because of the religious, spiritual or superstitious climate in which our musicians live. Great care is necessary to see that balneotherapy does not degenerate into harmful quackery or a lucrative but dangerous racket.

The vocal disorders mentioned above and their therapy are, of course general and apply equally to Indian music. But India is a huge subcontinent involving extreme variations in climate as well as habits of food and dress. The types of voice training required for Karnataka music and Hindustani music would appear to differ, at least in some major aspects. Therefore the Indian phoniatriest — when he comes to exist — has to take up research on the special problems of voice training, voice disorders and their treatment in the context of the above mentioned Indian conditions. Statistical and individual clinical methods have to be developed where and when necessary with the active and voluntary co-operation of musicians.

Before concluding this section on physiology (and related pathology and therapy), I shall briefly touch upon another important aspect of the voice : this is the natural transformation of the voice corresponding to physiological and psychological transitions occurring with age changes in men and women. These are the phenomena of vocal mutation and vocal senescence. While

anterior pituitary activity in the form of the somatotrophic hormone is common to both sexes through such common metabolic functions as the conversion of amino acids into proteins, increase of glucose concentration and decrease of insulin concentration in the blood stream, promotion of the enlargement of the skeletal frame etc., the androgens, androsterone and testosterone appear to transform the vocal apparatus more markedly than the estrogens. Thus the male voice becomes lower, rough and "cracked" during puberty. This follows rapid acceleration in growth of vocal cords and musculature in the laryngeal tube.

The vocal cords become thicker, less tense; and almost double their normal length; the phonation tube widens, laryngeal muscles become slightly rigid. Benign growths like polyps also appear sometimes concurrently. The corresponding acoustical effect is the loss or diminution of certain partials in the formant structure. Such drastic transformations are not manifested during female adolescence. However, it appears in a pronounced form during vocal senescence or involution. This occurs in the menopause period in women and after climacteric in men. In women this takes the form of squeaking, reduced intensity, reduced vocal stamina, husky, muffled, 'thin' or 'sharp' timbre, wobbling due to irregular expiration etc. Such changes result from decreased ascorbic acid concentration, tissue dehydration, degeneration of collagenous connective tissue, reduced endocrine function, pituitary hypophysis etc. Loss of vocal stamina and intensity, wobbling and lowering of pitch range also occur in men after climacteric. Nevertheless, the effect is more drastic in women than in men. Thus it would seem that pronounced changes occur in men at the initial progressive physiology change while in women they do in the final one. The reverse is true with respect to minor changes in men and women.

It must be remembered that adolescence and senescence are overall changes and involve a serious disturbance in the equilibria of intellectual, physiological and psychological activities of the individual. Further, menstrual dysodia is common among women singers because the hormonal imbalance occurring before and during menstruation introduces tensions in the intellect, emotion and body and these in turn strain the voice. Practice and performance of vocal music should therefore be avoided by women in their menstrual periods.

Several issues await investigation in respect of vocal mutation and vocal senescence : In temperate zones it is found that it is best to commence singing instruction not before 17 years in girls and not before 18-19 years in boys. What is the optimum age of girls and boys at which serious vocal instruction should commence in India? What corrective habits could be set up to modify the dimensions and tensile quality of the laryngeal vocal generator so as to produce a voice quality which is optimum for a given person?

What psychological techniques and psychotherapeutic tools could be employed during adolescence to yield the best in a given voice and to correct disorders? To what extent may competitive inhibition in hormones and hormonal supplementation be used during vocal mutation and vocal senescence to counteract undesirable vocal transformations without producing undesirable side effects? Is it possible, and not undesirable, to lengthen the period of mutation so that voice-engineering could be taken up systematically? The value of these and similar investigations becomes obvious if it is remembered that not even the slightest intelligent attempt is being made in India to seek out and train good voices and to offer relief for the many ills besetting our singers and that vocal music is still the most important mode of communication in Indian music, be it classical, light, film or folk music. One of the main reasons why Indian vocal music is not as popular outside India as it should or could be, is the poor quality of the voices of a large section of our vocalists.

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